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INCIDENCE AND ETIOLOGY OF
VENTILATOR ASSOCIATED PNEUMONIA

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CERTIFICATE

This is to certify that the dissertation titled **" INCIDENCE AND ETIOLOGY OF VENTILATOR ASSOCIATED PNEUMONIA "** is the bonafide original work of **Dr. E.RAJALAKSHMI** in partial fulfilment of the regulation for M.D. Branch–I (General Medicine) Examination of the Tamilnadu Dr. M.G.R Medical University to be held in MARCH 2010. The Period of study was from JANUARY 2008 to JUNE 2009.

Prof.A.RADHAKRISHNAN,M.D.
Professor Of Medicine,
Madras Medical College and Research Institute,
Govt. General Hospital,
Chennai – 600 003.

Prof.C.RAJENDIRAN,M.D.
Director,& professor
Institute of Internal Medicine,
Madras Medical College and Research Institute,
Govt. General Hospital,
Chennai -600 003.

Prof.J.MOHANASUNDARAM,M.D,DNB,PhD
Dean.Madras Medical College and Research Institute, Govt.GeneralHospital,
Chennai-600 003.

DECLARATION

I, **Dr.E.RAJALAKSHMI** solemnly declare that dissertation titled **"INCIDENCE AND ETIOLOGY OF VENTILATOR ASSOCIATED PNEUMONIA "** is a bonafide work done by me at Madras Medical College and Govt. General Hospital from January 2008 to June 2009 under the guidance and supervision of my unit chief **prof.A.RADHAKRISHNAN,MD.,** Professor of Medicine.

This dissertation is submitted to Tamilnadu Dr. M.G.R Medical University, towards partial fulfilment of regulation for the award of M.D. Degree (Branch – I) in General Medicine.

Dr.E.RAJALAKSHMI
Post graduate student,
M.D.General medicine
Institute of Internal Medicine,
Madras Medical College
Govt. General Hospital,
Chennai -600 003

Place: chennai

Date :

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CONTENTS

ABBREVATIONS

VAP - Ventilator associated pneumonia

TLC - Total leukocyte count

BAL - Bronchoalveolar lavage

ETA - Endotracheal aspiration

EO VAP - Early onset VAP

LO VAP -Late onset VAP

MRSA - Methicillin resistant staph. aureus

HAP - Hospital acquired pneumonia

BBS - Blind bronchial biopsy

CPIS -Clinical pulmonary infection score

ABG - Arterial blood gas

MDR - Multidrug resistance

SSD -Supraglottic secretion draining

CASS - Continuous aspiration of supraglottic secretions

QEA - Quantitative culture of endo tracheal aspirate

PTC -Protected telescopic catheter

MV -Mechanical ventilation

NP -Nosocomial pneumonia

ARDS -Acute respiratory distress syndrome

INTRODUCTION

Pneumonia is the second most common nosocomial infection in critically , affecting 27% of all critically ill patients. Pneumonia is defined as Nosocomial when it occurs more than 48 hours after the patient's admission to the hospital and when it was not in incubation at the time of hospitalisation.[2] Ventilator Associated Pneumonia (VAP) is a subset of pneumonia and the term refers to nosocomial pneumonia in a patient on mechanical ventilatory support (by endotracheal tube or tracheostomy) for greater than or equal to 48 hours.

Ventilator-associated pneumonia (VAP) continues to be a major threat to patients admitted in intensive care units (ICU) and receiving mechanical ventilation (MV). Eighty-six percent of nosocomial pneumonias are associated with mechanical ventilation and are termed ventilator-associated pneumonia (VAP). [3]

A VAP arising 48 to 96 hours after tracheal intubation usually is called "early-onset VAP", and the one that occurs after this period as the "late-onset VAP" .Generally, early-onset VAP has a better prognosis and is more likely to be caused by aspiration of antibiotic-sensitive bacteria colonizing the oropharynx. Late-onset VAP may be

caused by more unusual or multidrug-resistant (MDR) pathogens and is associated with greater morbidity and mortality.

Endotracheal intubation has been identified as a risk factor for developing VAP.Critically ill patients who are intubated for more than 24 hours were found to be at 6 to 21 times higher risk of developing ventilator-associated pneumonia and those patients intubated for less than 24 hours are at 3 times the risk of VAP , compared to non-intubated patients. Other risk factors for VAP include decreased level of consciousness, gastric distention, and presence of gastric or small intestine tubes, trauma, or COPD. VAP is reported to occur at rates of 10 to 35 cases / 1000 ventilator days, depending on the clinical situation.

Aspiration of oral and /or gastric fluids is recognized to be an essential step in the development of VAP. Pulmonary aspiration is increased by supine positioning and pooling of secretions above the ET tube cuff . Estimates of attributable mortality are variable,but increased duration of ventilation is a consistent finding, along with the corresponding increase in hospital days and cost.

A major component of the problem is the ineffectiveness of therapy once VAP is diagnosed. Brun-Buisson et al have demonstrated failure rates of 49 to 62% despite the use of standard antibiotic combinations. Given the burden of VAP, both physical and financial, and the difficulties in treatment, prevention strategies would appear to be of paramount importance.

In this study incidence , etiology-the profile of the organisms, percentage of EOP/LOP, underlying risk factors and their added morbidity & mortality were analysed.

AIMS AND OBJECTIVES

1. To study the incidence and aetiology of VAP
2. To analyse the underlying risk factors for VAP
3. To study the percentage of early and late onset pneumonia in these patients
4. To study the morbidity and mortality attributed by VAP

REVIEW OF LITERATURE

Pneumonia is the second most common nosocomial infection in critically ill patients, affecting 27% of all critically ill patients[1] .Severe hospital acquired pneumonia (HAP) continues to pose diagnostic and therapeutic challenges to the clinician. It is an important clinical problem because it is common, causes significant increase in mortality and increases duration of hospitalisation.

The incidence of HAP has been reported to range from 4 to10 cases per 1000 hospitalisations.[3]The large variation in the incidence of HAP is in part due to the different criteria used in the diagnosis of HAP. Previous studies have shown mortality rates from 8.9% to 70% with higher mortality in surgical patients, ventilated patients and the type of causative organism.

Definition

NOSOCOMIAL PNEUMONIA

Pneumonia, which is parenchymal lung infection, is defined as Nosocomial when it occurs more than 48 hours after the patient's admission to the hospital and when it was not in incubation at the time of hospitalization. Eighty-six percent of nosocomial pneumonias are associated with mechanical ventilation and are termed ventilator-associated pneumonia (VAP).VAP occurs in up to 25% of all people who require mechanical ventilation.

Ventilator-associated pneumonia (**VAP**)

Sub-type of hospital-acquired pneumonia (HAP) which occurs in people who are on mechanical ventilation through an endotracheal or tracheostomy tube for at least 48 hours. VAP is a medical condition that results from infection which floods the small, air-filled sac (alveoli) in the lung responsible for absorbing oxygen from the atmosphere. VAP is distinguished from other kinds of infectious pneumonia because of the different types of microorganisms responsible antibiotics used to treat, methods of diagnosis, ultimate prognosis, and effective preventive measures. In the community pneumonia is most often caused by *S.*pneumoniae, H. influenzae, or S. aureus. However, in the hospital the organism associated with pneumonia is most often Pseudomonas, regardless of whether or not the patient is ventilated.[5]

The daily hazard rate for first episodes of VAP was high for the first several days (3.3% per day at Day 5), and then decreased to 1.3% per day after Day 15, documenting a dramatic decline in pneumonia over time. This is because the

intubation process itself contributes to the development of VAP. VAP occurring early after intubation typically involves fewer resistant organisms and is thus associated with a more favourable outcome.

Independent predictors of ventilator-associated pneumonia in their Cohort were a primary admitting diagnosis of burns (risk ratio, 5.09 [95% CI, 1.52 to 17.03]), trauma (risk ratio, 5.0 [CI, 1.91 to 13.11]), central nervous system disease (risk ratio, 3.40 [CI, 1.31 to 8.81]), respiratory disease (risk ratio, 2.79 [CI, 1.04 to 7.51]), cardiac disease (risk ratio, 2.72 [CI, 1.05 to 7.01]), mechanical ventilation in the previous 24 hours (risk ratio, 2.28 [CI, 1.11to4.68]), witnessed aspiration (risk ratio, 3.25 [CI, 1.62 to 6.50]), and paralytic agents (risk ratio, 1.57 [CI, 1.03 to 2.39])

VAP is classified in to early-onset VAP (EOP) and late-onset VAP, defined with the cut-off between 5 to 7 days of mechanical ventilation.

Symptoms and signs

People who are on mechanical ventilation are often sedated and are rarely able to communicate. As such, many of the typical symptoms of pneumonia will either be absent or unable to be obtained. The most important symptoms are fever, low body temp, new purulent sputum, and hypoxia (decreasing amounts of oxygen in the blood).

Risk factors [6,7]

- Elderly age

- H/o transfer out from IMCU
- Witnessed aspiration
- Diabetes
- Reintubation
- Cerebral diseases

The spectrum of cerebral disease in these patients included meningitis, meningoencephalitis, Parkinson's disease, dementia and cerebral infarction. Patients at risk for staphylococcal VAP include end-stage renal disease, comatose, or neurosurgical patients,especially if nasal colonization is documented.[25]

Pathophysiology

VAP primarily occurs because the endotracheal or tracheostomy tube allows free passage of bacteria into the lower segments of the lung in a person who often has underlying lung or immune problems. Bacteria travel in small droplets both through the endotracheal tube and around the cuff.[27,28] Bacteria colonize the endotracheal or tracheostomy tube and are embolized into the lungs with each breath. Bacteria may also be brought down into the lungs with procedures such as deep suctioning or bronchoscopy.

Whether bacteria also travel from the sinuses or the stomach into the lungs is, controversial.[26] However spread to the lungs from the blood stream or the gut is uncommon. Once inside the lungs, bacteria then take advantage of any deficiencies in the immune system (such as due to malnutrition or chemotherapy) and multiply. A

combination of bacterial damage and consequences of the immune response lead to disruption of gas exchange with resulting symptoms.

The main route of VAP occurrence is aspiration of pathogenic gram-positive and gram-negative bacteria, and colonization on the oropharynx and gastrointestinal tract.

Under normal conditions, the host defense, including filtration and humidification of air in the upper airways, epiglottic and cough reflexes, ciliary transport by respiratory epithelium, phagocytes in distal lung, and systemic cell mediated and humoral immunity, prevent bacterial invasion.

In intensive care units, the host defenses of patients are usually distorted because of their underlying diseases and invasive devices that are used. Patients are not able to cough efficiently due to sedation or underlying disease. Also when they are intubated, the endotracheal tube holds the vocal cords open and facilitates aspiration. As a consequence, the endotracheal or tracheostomy tube allows free passage of bacteria into the lower segments of the lung in a person who often has underlying lung or immune problems. Bacteria travel in small droplets both through the endotracheal tube and around the cuff.

Once bacteria reach the distal lung, they multiply and cause invasive disease. Moreover, bacteria then take advantage of any deficiencies in the immune system of the host to continue to multiply and worsen the condition. A combination of bacterial damage and consequences of the immune response lead to disturbances of gas exchange with resulting symptoms.

Morbidity and mortality associated with the development of VAP is high, with mortality rates ranging from 20 to 41%.[8] It has been shown that the development of VAP increases the length on the mechanical ventilator by 4 days, critical care and hospital lengths of stay (LOS) by 4 and 9 days, respectively and results in > $40,000 additional costs.[9]

Microbiology [5]

The microbiologic flora responsible for VAP is different from that of the more common community-acquired pneumonia (CAP). In particular, viruses and fungi are uncommon causes in people who do not have underlying immune deficiencies.

Though any microorganism that causes CAP can cause VAP, there are several bacteria which are particularly important causes of VAP because of their resistance to commonly used antibiotics. These bacteria are referred to as multidrug resistant(MDR).

Pseudomonas aeruginosa is the most common MDR Gram-negative bacterium causing VAP. Pseudomonas has natural resistance to many antibiotics and has been known to acquire resistance to every antibiotic except for polymyxin B. Resistance is typically acquired through up regulation or mutation of a variety of efflux pumps

which pump antibiotics out of the cell. Resistance may also occur through loss of an outer membrane porin channel (OprD)

Klebsiella pneumoniae has natural resistance to some beta-lactam antibiotics such as ampicillin. Resistance to cephalosporins and aztreonam may arise through induction of a plasmid-based extended spectrum beta-lactamase (ESBL) or plasmid-based ampC-type enzyme.

Serratia marcescens has an ampC gene which can be induced by exposure to antibiotics such as cephalosporins. Thus, culture sensitivities may initially indicate appropriate treatment which fails due to bacterial response.

Enterobacter as a group also have an inducible ampC gene. Enterobacter may also develop resistance by acquiring plasmids.

Citrobacter also has an inducible ampC gene.

Stenotrophomonas maltophilia often colonizes people who have endotracheal tubes or tracheostomies but can also cause pneumonia. It is often resistant to a wide array of antibiotics but is usually sensitive to co-trimoxazole.

Acinetobacter are becoming more common and may be resistant to carbapenems such as imipenem and meropenem.

Burkholderia cepacia is an important organism in people with cystic fibrosis and is often resistant to multiple antibiotics.

Methicillin-resistant Staphylococcus aureus is an increasing cause of VAP. As many as fifty percent of Staphylococcus aureus isolates in the intensive care setting are resistant to methicillin. Resistance is conferred by the mecA gene.

Diagnosis [10,11]

VAP should be suspected in any person developing fever increasing numbers of white blood cells on blood testing, and new shadows (infiltrates) on a chest x-ray. Blood cultures may reveal the microorganism causing VAP.

Diagnostic criteria

A new and persistent (>48-h) infiltrate on chest radiograph 48 hours after admission to hospital not explained by other pathology such as pulmonary oedema and not deemed to be incubating at the time of admission into hospital, and Plus two or more of the three criteria

(i) Fever of >38.3°C,

(ii) Leukocytosis of >12 × 10^9/ml, and/or

(iii) Purulent tracheobronchial secretions

This criteria has sensitivity of 69% and a specificity of 75% for establishing the diagnosis of VAP.

Diagnostic strategy

Two strategies exist for diagnosing VAP. One strategy collects cultures from the trachea of people with symptoms of VAP plus a new or enlarging infiltrate on chest x-

ray. The next is more invasive and advocates a bronchoscopy plus bronchoalveolar lavage (BAL) for people with symptoms of VAP plus a new or enlarging infiltrate on chest x-ray.In both cases, VAP is not diagnosed when cultures are negative and another source of the symptoms is sought.

TAs are adequate specimens when strict definitional criteria (organisms on Gram staining and fewer than 10 squamous epithelial cells per low-power field [magnification, ×100]) are followed.

Although VAP spreads to the blood or pleural space in <10% of cases, if an organism known to cause pneumonia is cultured in the setting of clinically suspected pneumonia, treatment is warranted. Consequently, most experts recommend that two sets of blood cultures and a thoracocentesis for nonloculated pleural effusions of ≥10 mm in diameter on a lateral decubitus chest radiograph should be part of the evaluation of suspected VAP. [12] If the effusion is loculated, ultrasound guidance may be required.

However, it is important to keep in mind not only that the sensitivity of blood cultures for the diagnosis of VAP is less than 25% but also that when positive, the organisms may originate from an extrapulmonary site of infection in as many as 64% of cases and even when VAP is present.

Because of the poor specificity of the clinical diagnosis of VAP and of qualitative evaluation of ETAs, Pugin et al. developed a composite clinical score, called the clinical pulmonary infection score (CPIS), based on six variables:

(i) Temperature,

(ii) Blood leukocyte count

(iii) volume and purulence of tracheal secretion

(iv) oxygenation,

(v) pulmonary radiography, and

(vi) semi quantitative culture of tracheal aspirate. [13,14.]

The score varied from 0 to 12. A CPIS of >6 had a sensitivity of 93% and a specificity of 100%.

CPIS Score

Day	Parameter	Value for score of 1 point	Value for score of 2 points
1	Temp (°C)	38.5 to 38.9	≥39 or ≤36
	White blood cells/mm3	<4,000 or >11,000	<4,000 or _11,000 & ≥50% bands
	Secretions	Nonpurulent	Purulent
	PaO2/FiO2		≤240 & no ARDS
	Chest X-ray infiltrates	Diffuse or patchy	Localized
3	Temp (°C)	38.5 to 38.9	≥39 or ≤36
	White blood cells/mm3	<4,000 or >11,000	<4,000 or >11,000 & ≥50% bands
	Secretions	Nonpurulent	Purulent
	PaO2/FiO2		≤240 & no ARDS
	Chest X-ray infiltrates	Diffuse or patchy	Localized
	Progression of chest X-ray infiltrates		Yes
	Sputum	Culture >1+	Culture >1+ and same organism on Gram stain

As multiple etiologies may explain why patients develop a fever and pulmonary infiltrates while receiving mechanical ventilation, we have to search for other infectious and non-infectious etiologies concurrently with evaluation for VAP. The extent of this investigation is dictated by the clinical circumstances, including physical examination, laboratory findings, and the severity of illness.

Evaluation for infectious (other than VAP) and non-infectious causes of fever

Action to be considered

i. Changing and/or culturing intravenous lines
ii. CT scan of sinuses, with fine needle aspirate if abnormal
iii. Evaluation for venous thromboembolism
iv. Clostridium difficile evaluation if diarrhea present
v. Abdominal ultrasound and/or CT scan (especially in the case

Abnormal abdominal physical examination, abnormal liver function tests, elevated lipase/amylase, or presence of predisposing factors (abdominal surgery, pancreatitis, gastrointestinal bleed or malignancy, or high-dose corticosteroids)

vi. Lumbar puncture (especially in the case of a predisposing factor such as head trauma or neurosurgical procedure)
vii. Drug fever

There is a general consensus that VAP is very likely in certain situations.

These circumstances are outlined below.

High probability of VAP

a) Radiographic evidence of cavitation or necrosis of the pulmonary infiltrate, particularly if rapid and progressive
b) An empyema with an adjacent pulmonary infiltrate
c) Simultaneous recovery of the same microorganism from respiratory secretions and pleural fluid
d) Simultaneous recovery of the same microorganism from respiratory secretions and blood, with no other source of the bacteremia
e) Consistent histology on lung biopsy
f) Positive Gram stain/culture on transthoracic needle aspirate
g) Chest X ray demonstrating an air space process abutting a fissure& air bronchogram, especially if single

Nonquantitative or semi quantitative airway sampling

Gram staining and nonquantitative and semi quantitative cultures of tracheal secretions have the advantages of reproducibility and of requiring little technical expertise and no specialized equipment or technique. However, these studies add little to the sensitivity and specificity the clinical diagnosis of VAP, as the upper respiratory tract is rapidly, within hours of intubation, colonized by potential pulmonary pathogens, even when pneumonia is not present. Thus, if an organism is cultured or noted on Gram stain, one does not know if it is

The cause of the pneumonia or simply colonization. In a study of 48

Patients with respiratory failure, concordance between tracheal non quqntitative cultures and cultures of lung tissue from open lung biopsy was only 40% [96]in that study, of those patients with pneumonia on lung histology, endotracheal aspirate (ETA had a sensitivity of 82% but a specificity of only 27%.

Only 15% of ETAs are adequate specimens when strict definitional criteria (organisms on Gram staining and fewer than 10 squamous epithelial cells per low-power field magnification, ×100) are followed .

Nonquantitative and semi quantitative cultures of ETAs for the diagnosis of VAP are most useful if the specimen is adequate and antimicrobial therapy has not been added or changed in the prior 72 h. The negative predictive value of these cultures in this setting is high (94%).

Quantitative cultures of airway specimens

To potentially improve the specificity of the diagnosis of VAP and the consequent unnecessary antibiotic use and its associated problems, numerous studies have investigated the role of quantitative cultures of respiratory secretions.

These have included nonbronchoscopic methods such as quantitative cultures of ETAs (QEAs) and sampling of secretions from distal airways “blindly” via an endobronchial catheter [15,16,17]. Blind bronchial sampling (BBS), PSB, protected telescoping catheter (PTC), BAL, and protected BAL (mini-BAL) samples can be obtained via the latter method.

Bronchoscopic sampling methods permit quantitative cultures of PSB, PTC, and protected and nonprotected BAL specimens.[18-21.]

The PSB and PTC are double-sheathed catheters with a biodegradable plug occluding the distal end of the inner catheter to minimize bacterial contamination.

The PSB and PTC procedures involve placing the tip of the bronchoscope or "blindly placed" catheter next to an involved bronchial segmental orifice. With bronchoscopy, direct visualization is possible.[22] With a "blind" procedure, the catheter is advanced until resistance is met and then retracted a few centimetres. The inner catheter is then advanced 2 or 3 cm beyond the outer catheter, ejecting the plug. With PSB, a brush is further advanced and rotated several times; with PTC, a 10-ml syringe is used to perform three brief aspirations of secretions. BAL involves the infusion and aspiration of sterile saline through a flexible fiber-optic bronchoscope or "blindly placed" catheter wedged into a bronchial segmental orifice. Protected BAL involves a specialized balloon-tipped catheter with a distal ejectable plug. When performing a BAL to diagnose VAP, instillation of at least 140 ml of saline is required to maximize diagnostic yield .

If a bronchoscopically directed quantitative culture is chosen, the patient should receive adequate sedation, with consideration of a short-acting paralytic agent to prevent coughing during the procedure. The endotracheal tube must be ≥1.5 mm larger than the external diameter of the flexible bronchoscope. The patient should receive a fraction of inspired oxygen (FiO_2) of 100%, and positive-end expiratory pressure should be reduced as much as tolerated. To maximize ventilation and minimize air trapping, the peak inspiratory flow

should be decreased to ≤60 litres/min, the respiratory rate set between 10 and 20 breaths/min, and the peak inspiratory pressure alarm increased.

The patient should be carefully monitored throughout the procedure, with particular attention to exhaled tidal volume, peak inspiratory pressure, oxygen saturation, the electrocardiogram, and vital signs. Secondary hypotension should be anticipated, and appropriate intravenous fluids and vasopressors should be available for immediate administration .

The sampling area should be chosen based on the location of the infiltrate on chest X ray or CT scan. This typically corresponds to the bronchial segment with purulent secretions and/or where endobronchial abnormalities are maximal, which can be clues in the setting of diffuse pulmonary infiltrates or minimal changes in a previously abnormal chest X ray . When in doubt, sample the posterior right lower lobe, since autopsy studies have indicated that VAP frequently involves this area.

The presence of more than 1% epithelial cells or 10 epithelial cells per low-power field (magnification, ×100) in bronchoscopic or “blind” BAL, PSB, PTC, or bronchial sampling suggests heavy oropharyngeal colonization. Returns of <10% of the instilled BAL fluid are probably not representative of the lower respiratory tract . For QEAs, the same criteria mentioned above for nonquantitative and semi quantitative cultures of an ETA should be For each of the quantitative culturing methods, threshold values have been derived and are expressed in CFU per millilitre. If the number of CFU/ml is equal to or exceeds the threshold values for the particular technique, a diagnosis of pneumonia is made. Threshold values often employed for diagnosing pneumonia by quantitative cultures are $\geq 10^5$ to 10^6, $\geq 10^4$, and $\geq 10^3$ CFU/ml for QEA, bronchoscopic BAL, and PSB, respectively, with $\geq 10^5$ CFU/ml being the

most widely accepted value for QEA . For “blind” distal sampling, the thresholds are $\geq 10^3$ CFU/ml for PSB and mini-BAL and $\geq 10^4$ CFU/ml for cultures obtained with BBS and unprotected utilized.

Treatment

Treatment must be obtained quickly and treatment initiated without delay .Principles to apply when choosing appropriate therapy for VAP include knowledge of organisms likely to be present, local resistance patterns within the ICU, a rational antibiotic regimen, and a rationale for antibiotic de-escalation or stoppage. Early effective therapy for VAP is associated with reduced mortality. Luna et al. demonstrated that inadequate therapy during the initial 48 h, despite provision of adequate therapy after BAL results, was associated with a mortality rate of 91% . When empirical therapy was appropriate, mortality rates were much lower (38%). Delays in the administration of appropriate antibiotic therapy for VAP have been associated with excess mortality . In one study, a delay in appropriate therapy for 24 h or more was associated with a 69.7% mortality, compared to 28.4% in patients treated without the delay

($P < 0.001$).[23,24]

A low threshold for suspicion of VAP is needed when a patient's clinical course deteriorates. The day 1 CPIS can be useful, especially when combined with quantitative cultures. The choice of which quantitative culture methodology to use is an open debate. However, diagnostic cost favours QEA, which can also be implemented as a surveillance technique.

Antibiotic administration should be promptly initiated when VAP is suspected and quantitative cultures obtained and should be broad in coverage. Knowledge of local antibiograms should guide the choice of antibiotics, in addition to likelihood of organisms (early- or late-onset VAP). For patients already on antibiotics at the time of suspected VAP, the clinician should choose antibiotics from different classes, as it is likely that resistance to "in-use" antibiotics has developed.

Assessment of the likelihood of VAP by day 3 is needed to decide whether antibiotics should be continued. The assessment should include a repeat CPIS, as the change in CPIS can guide clinical decisions, even stoppage of antibiotics. Assessment of quantitative culture results and sensitivities at this juncture is prudent, as it may permit early antibiotic de-escalation by choosing a more narrowly focused agent(s). Monotherapy may be appropriate in many instances of VAP and should reduce the incidence of drug resistance. A change to monotherapy may be possible in a responding patient where organism sensitivity results permit. A short course (6 to 8 days) can be administered to patients with VAP but is dependent on the patient physiologic response to treatment along with which organisms have been recovered

Treatment of VAP should be matched to known causative bacteria. However, when VAP is first suspected, the bacteria causing infection is typically not known and broad-spectrum antibiotics are given (empiric therapy) until the particular bacterium and its sensitivities are determined. Empiric antibiotics should take into account both the risk factors a particular individual has for resistant bacteria as well as the local prevalence of resistant microorganisms. If a person has previously had episodes of pneumonia, information may be

available about prior causative bacteria. The choice of initial therapy is therefore entirely dependent on knowledge of local flora and will vary from hospital to hospital.

ATS has recently published guidelines to guide empirical antibiotic choices .These guidelines are divided into those for patients at risk for VAP caused by multidrug-resistant organisms and those for patients without such risk. Risk factors for multidrug-resistant organisms include prior antimicrobial therapy in the preceding 90 days, current hospitalization exceeding 5 days (not necessarily ICU days), high frequency of resistance in the community or local hospital unit, and immunosuppressive disease and/or therapy and ventilation for more than five days, Residence in a nursing home, Treatment in a haemodialysis clinic. .

People who do not have risk factors for MDR organisms may be treated differently depending on local knowledge of prevalent bacteria.

In the absence of risk factors for multidrug-resistant bacteria, the clinician should choose empirical therapy for *Streptococcus pneumoniae, Haemophilus influenzae,* methicillin-sensitive *Staphylococcus aureus*, and antibiotic-sensitive gram-negative enteric organisms. Antibiotic choices include ceftriaxone, quinolones (levofloxacin, moxifloxacin, or ciprofloxacin*),* ampicillin/sulbactam, or ertapenem.

Antibiotic choice can be tailored to the pathogens' last sensitivity report should QEA surveillance cultures be obtained twice weekly and should the growth level exceed 100,000 CFU/ml.

When risk factors for multidrug-resistant organisms are present, the clinician must consider not only the organisms listed above but also *Pseudomonas aeruginosa, Klebsiella,*

Enterobacter, Serratia, Acinetobacter, Stenotrophomonas maltophilia, Burkholderia cepacia, and methicillin-resistant *S. aureus*. Empirical therapy is broadened to include

(i) Either an antipseudomonal cephalosporin (cefepime or ceftazadime), an antipseudomonal carbepenem (imipenem or meropenem), or a β-lactam/β-lactamase inhibitor (pipercacillin-tazobactam) plus

(ii) An antipseudomonal fluoroquinolone (ciprofloxacin or levofloxacin) or an aminoglycoside (amikacin, gentamicin, or tobramycin) plus linezolid or vancomycin[30.]

Possible empirical therapy combinations include (but are not limited to):

- Vancomycin/linezolid and ciprofloxacin,
- Cefepime and gentamicin/amikacin/tobramycin
- Vancomycin/linezolid and ceftazidime
- Ureidopenicillin plus β-lactamase inhibitor such as piperacillin/tazobactam or ticarcillin/clavulanate
- Carbapenem (e.g., imipenem or meropenem)

Therapy is typically changed once the causative bacteria are known and continued until symptoms resolve (often 7 to 14 days).

There is ongoing research into inhaled antibiotics as an adjunct to conventional therapy. Tobramycin and polymyxin B are commonly used in certain centers but there is no clinical evidence to support their use.

PREVENTION

General measures

Prevention of VAP involves limiting exposure to resistant bacteria, discontinuing mechanical ventilation as soon as possible, and a variety of strategies to limit infection while intubated. Resistant bacteria are spread in much the same ways as any communicable disease. Proper hand washing, sterile technique for invasive procedures, and isolation of individuals with known resistant organisms are all mandatory for effective infection control. A variety of aggressive weaning protocols to limit the amount of time a person spends intubated have been proposed. One important aspect is limiting the amount of sedation that a ventilated person receives.

Specific measures

The ability to prevent EOP is clearly greater than that of late-onset VAP. Many of the best-validated strategies for VAP prevention, including CASS, are for EOP.EOP can also be prevented by other strategies, such as by simply administering ventilation with patients in the semirecumbent position,prophylactic short course, high dose antibiotic therapy, and others Having the ability to prevent late-onset VAP is much more difficult. The pathogenesis is different than EOP.

Antibiotic selective pressure and cross infection are themes that common to late-onset VAPs. Many late-onset VAPs, especially Pseudomonas,occurwithout preceding oropharyngeal or gastric colonization the target of many prevention strategies.

No prevention strategy has shown a clear-cut benefit for late-onset VAP. The best prevention strategies may actually be an accurate diagnosis of EOP and avoidance of antibiotics as much as possible[31].

Potential strategies to prevent VAP

I. Prior to intubation

(i) Address reversible causes of respiratory failure-bronchospasm ,analgesia,sedation

(ii) Non invasive mechanical ventilation

II. Process of intubation

1) Avoid gastric distension
2) Oroendotracheal route

III. After intubation(data supported)

1) Oral route gastric tube
2) Head end elevation 30-45 degrees
3) Good hand hygiene
4) Closed suctioning
5) Continuous sub glottis suctioning
6) Rotational beds
7) Chlorhexidine oral rinse in cardiac patients

8) Minimise sedation

9) Weaning protocols

IV. After intubation(controversial)

1) Early vs late enteral nutrion
2) Selective gut decontamination
3) Rotational antibiotic schema
4) Antibiotic impregnated endotracheal tube

Non-invasive mechanical ventilation (NIV) has been associated with more favourable outcomes (mortality and morbidity) in comparison to endotracheal tube placement in patients with acute exacerbations of chronic obstructive pulmonary disease or acute pulmonary oedema .[32,-35]

The incidence of nosocomial pneumonia was reduced in the group randomized to NIV Furthermore, immunocompromised patients with bilateral infiltrates also benefited from NIV over invasive mechanical ventilation (IMV) with regard to both mortality and morbidity. [34]

Once the decision to intubate is made, the practice of VAP prevention should be directed at reducing colonization and aspiration (volume of organisms presented to the lungs). This begins with choosing the oral route of intubation and focusing on minimizing the duration of mechanical ventilation (DOMV).

Oral intubation is preferred over nasal intubation, as the latter has been associated with both VAP and sinusitis, with the same bacteria identified in both. Rouby et al., demonstrated a significant reduction in nosocomial sinusitis when patients are orally cannulated with endotracheal and gastric tubes.[35]

Holzapfel et al. have linked the reduction in nosocomial sinusitis to a reduction in VAP.[36]

Furthermore, the clinician must give careful attention to the mundane and seemingly small interventions, such as regularly assessing endotracheal cuff pressure, performing endotracheal suctioning, draining ventilator tube condensate, avoiding gastric overdistention, avoiding the supine position, avoiding unnecessary ventilator circuit changes, application of heat and moisture exchangers (HMEs) when appropriate, minimizing out-of-ICU transports, and regular hand cleaning with soap or alcohol disinfectant.

Maintaining cuff pressure of endotracheal tubes at ≥20 mm Hg reduces nosocomial pneumonia, presumably by minimizing the passage of oropharyngeal contents into the trachea. [37]

The duration of intubation directly affects the likelihood of VAP, which is more evident in patients with ICU LOS exceeding 5 days. Fagon et al. suggested that the incidence of VAP increases by 1% per day of IMV . However, Cook et al. found that the incidence per day varies over time, with 3% per day during first 5 days of IMV, 2% for the second 5 days, and 1% for the subsequent 5-day period [38]. This observation is supported by Ibrahim et al., who identified an incidence rate of VAP of 11.5%, 56% of which were early onset (≤5 day) [39]. Hence, the greatest attack rates appear to be during the initial days of mechanical ventilation.

Additionally, significant risk factors for early-onset VAP include cardiopulmonary resuscitation and continuous sedation.[40]

Continuous sedation is more often administered in the acute phase of an illness. In addition to treating the primary cause of respiratory failure, the DOMV can be reduced through judicious use of sedatives and analgesics.

Studies by Brook et al. and Kress et al. have demonstrated that protocols for sedative and analgesic administration with the goal of minimizing constant infusions led to reduced DOMV.[41,42] Furthermore, daily interruption of sedation results in a reduced incidence of intensive care unit complications, in which VAP was included. [43,44.]

Weaning protocols have also resulted in reduced DOMV, whether respiratory therapist initiated or not.[45,46]

Patients should be cared for in the semi recumbent position to reduce the extent of aspiration, especially when receiving enteral feeds.

Radionuclide studies reveal increased tracheal penetration of gastric contents when intubated patients are supine [47] Drakulovic et al. found that the simple elevation of the head of bed to 45° results in dramatic reductions in VAP incidence and a trend toward reduced mortality [48.] Nonetheless, a recent survey by the University Hospital Consortium revealed that compliance with the simple and no-cost intervention of elevating the head is woefully low, and a study by Heyland et al. revealed that the head of bed is on average elevated to 29° and not 45°. [49] .

Compared to supine positioning, studies have shown that simple positioning of the head of bed to 30° or higher significantly reduces gastric reflux and VAP (8% versus 34%,

respectively). Kinetic bed therapy has also led to a reduction in the incidence of VAP.[50,51] However, this is costly and has not been directly compared to head-of-bed elevation, a no-cost option.

Some VAP is contracted from inhalation of bacteria through the ventilator circuit and may be a result of contaminated aerosols, condensate, or suction catheters. Traditionally, ventilator circuit changes have been on a regular schedule and often daily. However, the data examining this practice reveal that there is no benefit to changing the circuit on a regular basis, and the present recommendations are to change the circuit when soiled .[52] Such a practice would likely reduce the rate of accidental spillage of condensate into the airway.

As heated humidifiers enhance the amount of condensate, attention has been focused on HMEs. These devices have led to a reduction in VAP, albeit small, and should be used in patients without significant secretions or concern over the risk of obstruction.[53,54]. While changing the HME less frequently than every 48 h may lead to further reductions in VAP, care must be taken to carefully monitor for trapped secretions and subsequent airway obstruction or increments in the work of breathing[55].

Endotracheal suctioning of intubated patients can be performed through an open or closed system. In theory the closed system could reduce the incidence of VAP, but in practice this has not been demonstrated .[56,57] Cost analysis favours the closed system, as the enveloped catheter can be reused for suctioning and needs to be changed only when dysfunctional. [58] However, respiratory therapists have voiced concerns over residue build-up within the lumen of the endotracheal tube.

As most VAP follows from aspiration of oropharyngeal secretions, attention to proper cuff inflation pressures and endotracheal suctioning can affect the volume presented to the trachea.

The application of continuous suction of subglottic secretions through specialized endotracheal tubes will reduce the incidence of VAP .[59,60] Surprisingly, this was not associated a reduction in mortality, ICU LOS, or duration of mechanical ventilation.

While studying the application of continuous subglottic suctioning, Rello et al. noted a trend of increased VAP in patients with endotracheal cuff pressures of <20 cm H_2O[61.] Hence, it is recommended not only to assess cuff pressure for tracheal ischemia (which occurs when pressure exceeds 30 cm H_2O) but also to ensure that adequate cuff pressure (>20 mm Hg) is present.

American and Canadian guidelines strongly recommend the use of supraglottic secretion drainage (SDD) Special tracheal tubes with an incorporated suction lumen as the EVAC tracheal tube form Covidien / Mallinckrodt can be used for that reason. studies on the use of special ET tubes which remove secretions pooled above the cuff with continuous suction decrease VAP by 45 to 50 % (Cook, De Jonghe, Brochard, & Brun-Buisson, 1998; Valles et al., 1995). specialized endotracheal tubes that allow continuous aspiration of subglottic secretions.

The endotracheal tube itself is a reservoir for gram-negative bacteria. The buildup of a biofilm within endotracheal tubes occurs frequently. One study demonstrated that 84% of endotracheal tubes examined had a biofilm [62]. As documented by Inglis et al., this biofilm is

heavily laden with bacteria, usually gram-negative organisms.[63,64] At present, ongoing studies are directed at either eliminating this biofilm or reducing the bacterial load associated with it.

New cuff technology based on polyurethane material in combination with subglottic drainage (SealGuard Evac tracheal tube from Covidien/Mallinckrodt) showed significant delay in early and late onset of VAP.[2]A recent clinical trial indicates that the use of silver-coated endotracheal tubes may also reduce the incidence of VAP.

Oral decontamination with chlorhexidine has been shown to reduce the incidence of VAP in patients undergoing cardiac surgery, presumably by reducing oropharyngeal colonization.[65] Furthermore, numerous studies with oral decontamination antibiotic pastes alone or co administered with systemic antibiotics have shown a reduction in early VAP.[66-70] Two meta-analyses have suggested better results with oral decontamination alone than with the combination of oral and systemic prophylaxis. [71,72] With either approach, however, concern over the emergence of antibiotic-resistant organisms has tempered use, as has the labor intensity required to apply these regimens at the bedside. This is particularly true in ICUs housing organisms with high antibiotic resistance rates. [73-76] While often recommended, it appears not to be routinely practiced. Two recent studies will further the debate, as they demonstrated significant reductions in VAP and mortality with selective decontamination of the digestive tract. [77,78] These two studies were performed under conditions where selective

decontamination of the digestive tract is most effective, i.e., surgical intensive care units housing patients less likely to be colonized with resistant bacteria.

Gastric volumes and acidity affect the incidence of VAP. Reducing the acidity of gastric secretions and feeding will reduce bacterial overgrowth. However, in high-risk patients (ventilated for >48 h and coagulopathic), the risk of bleeding outweighs the risk of VAP from pH-modifying agents.[79] Hence, it is difficult to recommend against H_2 blockers or proton pump inhibitors. Sucralafate may indeed be superior from the viewpoint of VAP, but it is less effective with regard to prophylaxis of gastrointestinal bleeding, and thus it use is not warranted over H_2 blockers or proton pump inhibitors.[80-82.]

Multiple studies have examined post pyloric versus gastric feedings with regard to incidence of aspiration and development of VAP. These studies were small and inconclusive. In a meta-analysis, post pyloric feedings reduce the incidence of VAP and increased the nutrition delivered. [83]However, no single trial demonstrated that post pyloric tube feedings prevent VAP. The improved delivery of nutrition was likely the result of decreased gastric residual assessments and consequently fewer stoppages in continuous tube feedings.

A recent publication favoured a delay of greater than 5 days before initiating tube feedings, as the incidence of VAP was reduced [84]. Further data are needed to unconditionally embrace this practice.

Preventing Multidrug Resistance

Antibiotic cycling remains controversial. Employing a rotational schedule for empirical antibiotic administration for suspected VAP may indeed lead to a reduced incidence of

resistant organisms. [85-87] While such a strategy may not reduce the incidence of VAP, reductions in mortality may be seen.[87] This is likely a result of changes in resistance patterns resulting in a higher likelihood of choosing appropriate antibiotic regimens [88.] Because rotational schedules have primarily targeted reducing the resistance of gram-negative organisms, we do not know the impact of rotating antibiotics against gram-positive organisms, such as methicillin-resistant *S. aureus*. Furthermore, the frequency with which to rotate antibiotics remains unclear, as monthly and quarterly regimens have been assessed with documented successes. [87] Furthermore, the probability of antibiotic cycling leading to a reduction in antimicrobial resistance is low as determined through mathematical modelling. [89] At this juncture, it is premature to recommend rotating antibiotics or a rotational schema.

Multidrug resistance can also be reduced when patient-antibiotic PK/PD characteristics are accounted for. Early eradication minimizes the opportunity for a population of organisms to develop resistance. Peak concentrations for aminoglycosides 10-fold greater than MIC appear to inhibit the emergence of resistant organisms. [90,91] When choosing fluoroquinolones, resistant organisms are less likely to be seen when the 24-h area-under-the-curve/MIC levels are >100 for gram-negative bacteria and >40 for gram-positive bacteria.[92] Changes in medication frequency or infusion rates can increase the time that the antibiotic concentration exceeds the MIC. For β-lactams, monobactams, glycopeptides, and cabapenems this can be important in enhancing bactericidal activity, again reducing opportunities for resistant organisms to emerge.[93]

In summary, several opportunities to reduce the incidence of VAP are available to the clinician. Many are no-cost or minimal-cost interventions and should be implemented as part

of routine care protocols. Care of the critically ill should be directed at applying interventions that reduce mortality, minimize morbidity, shorten the length of stay, and reduce cost. Reducing VAP through the simple measures outlined does exactly that. We recommend that the clinician's practice include non-invasive mechanical ventilation over intubation when appropriate, oral intubation when an endotracheal tube is necessary, orogastric over nasogastric tubes, elevation of the head to at least 30°, minimization of sedation, administration of a proton pump inhibitor when prophylaxis is indicated, a frequency of ventilator tubing changes at 7 days or when soiled, avoidance or elimination of endotracheal tube leak, good technique in removal of condensate, and of course excellent hand hygiene. At this time we do not support the routine use of endotracheal tubes with subglottic suction capabilities, rotational beds, in-line suction systems, rotational antibiotic schemes, or selective gut decontamination.

Strategies and a more thorough discussion on prevention are within the ATS/Infectious Disease Society of America statement and papers by Kollef and by Dodek et al[94]-Zack et al. have demonstrated that a multifaceted and multidisciplinary approach to VAP prevention can indeed reduce the incidence. [95] Success is dependent upon persistent attention to detail, high compliance rates, and a champion.

Current standards related to prevention of VAP (The Ventilator Bundle)

0 The ventilator bundle is a group of evidence-based practices that, when implemented together for all patients on mechanical ventilation, result in dramatic reductions in the incidence of ventilator-associated pneumonia. The ventilator

bundle has four key components:

(i) Elevation of the head of the bed to between 30 and 45 degrees,

(ii) Daily "sedation vacation" and daily assessment of readiness to extubate,

(iii) Peptic ulcer disease (PUD) prophylaxis, and

(iv) Deep venous thrombosis (DVT) prophylaxis (unless contraindicated).

Passive humidifiers or heat moisture exchangers are preferred to reduce colonization of the ventilator circuit. Ventilatory-circuit condensation should be prevented from entering the endotracheal tubes and any inline nebulizer.

Studies comparing H2 receptor blockers with sucralfate have shown conflicting results, with a trend toward a reduction of VAP with the use of sucralfate.[11,12,13] These benefits were most notable with late-onset VAP. Use of noninvasiveventilation in the subgroup of respiratory failure patients with chronic airflow limitation is the prevention of VAP.

Epidemiology and prognosis

It has been shown that VAP prolongs both the duration of mechanical ventilation, the duration of ICU stay, and hospital length of stay. Moreover, patients who develop VAP have a higher mortality and crude hospital cost compared to patients without VAP.

Because respiratory failure requiring mechanical ventilation is itself associated with a high mortality, determination of the exact contribution of VAP to mortality has been difficult. As of 2006, estimates range from 33% to 50% death in patients who develop VAP. Mortality is more likely when VAP is associated with certain microorganisms *(*Pseudomonas, Acinetobacter*, Stenotrophomonas maltophilia),* blood stream infections, and

ineffective initial antibiotics. VAP is especially common in people who have acute respiratory distress syndrome (ARDS).

Studies have provided different results when determining attributable mortality, in part because of very different populations (less-acute trauma patients, acute respiratory distress syndrome [ARDS] patients, and medical and surgical ICU patients) and in part as a result of variances in appropriate empirical medical therapy during the initial 2 days. Beyond mortality, the economics of VAP include increased ICU lengths of stays (LOS) (from 4 to 13 days), and incremental costs associated with VAP have been estimated at between $5,000 and $20,000 per diagnosis.

Limitations

i. The number of patients who had VAP was small
ii. Quantitative cultures of sputum and endotracheal aspirate specimens were not done, and
iii. The method of obtaining specimens was from the endotracheal aspirate and not by BAL /PTC.
iv. The systemic signs of pneumonia such as fever, tachycardia, and leukocytosis are nonspecific; they can be caused by any state that releases the cytokines interleukin-1, interleukin-6, tumor necrosis factor alpha, and gamma interferon . Examples of such

conditions include trauma, surgery, the fibro proliferative phase of ARDS, deep vein thrombosis, pulmonary embolism, and pulmonary infarction.

v. Although a normal chest radiograph makes VAP unlikely, in one study of surgical patients, 26% of opacities were detected by computed tomography (CT) scan but not by portable chest X ray.

In addition, asymmetric pulmonary infiltrates consistent with VAP can be caused by numerous non-infectious disorders, including atelectasis, chemical pneumonitis, asymmetric cardiac pulmonary edema, pulmonary embolism, cryptogenic organizing pneumonia, pulmonary contusion, pulmonary haemorrhage, drug reaction, and asymmetric ARDS. The overall radiographic specificity of a pulmonary opacity consistent with pneumonia is only 27% to 35%.

vi. The above study based on clinical symptoms and tracheal culture has low sensitivity and specificity as the upper respiratory tract is rapidly, within hours of intubation, colonized by potential pulmonary pathogens, even when pneumonia is not present.

Thus, if an organism is cultured or noted on Gram stain, one does not know if it is the cause of the pneumonia or simply colonization. In a study of 48 patients with respiratory failure, concordance between tracheal non quantitative cultures and cultures of lung tissue from open lung biopsy was only 40%.

MATERIALS AND METHODS

1. STUDY POPULATION:

A total of 50 patients satisfying all inclusion & exclusion criteria were included for the study from the population of patients who underwent mechanical ventilation in our medical intensive care unit & toxicology . written consent was obtained from all patients attenders in the study after clearly explaining the study procedure .The patients were visited on day 3 of mechanical ventilation for diagnosis of VAP according to the clinical criteria and also on day 7 for classifying into EOP & LOP.

2. STUDY SETTING:

Patients admitted in imcu and toxicology underwent ventilation > 48 hrs in

MMC govt general hospital.

3. COLLABORATION DEPARTMENT:

IMCU & toxicology

Microbiology dept.

4. ETHICAL APPROVAL:

Institutional ethical committee approved the study

5. STUDY DURATION:

The study was conducted for a period from jan 2008 to jun 2009.

6. STUDY DESIGN:

Cross sectional study to evaluate the incidence of ventilation associated pneumonia and also the percentage of EOP & LOP.

INCLUSION CRITERIA:

Patients who were admitted and underwent mechanical ventilation for 48 hrs in medical intensive care and toxicology unit age > 12 yrs.

EXCLUSION CRITERIA:

- Age < 12 yrs
- Patients who have got lower respiratory tract infection on admission

  Pulmonary tuberculosis

  COPD

  ARDS

  Bronchial asthmatics

METHODS AND MATERIALS:

Patients who were admitted in IMCU & toxicology had underwent mechanical ventilation for 48 hrs were visited and the clinical criteria was applied to diagnose VAP.

Those patients who developed new and persistent infiltrates on CXR after 48 hrs of mechanical ventilation and developing fever > 38.3, purulent tracheoseophageal aspirate and with total leukocyte count > 10000.

The patients were diagnosed to have VAP based on the following criteria for VAP:

The presence of persistent and new chest x – ray infiltrates after 48 hrs of ventilation plus any two of the following three

1. fever > 38.3 C
2. total leukocyte count > 10,000
3. Purulent tracheal aspirate

The organism that caused VAP was defined as the organism which was Isolated from the sputum or endotracheal aspirate which was sent for culture and sensitivity. The day of onset of VAP was noted to classify into EOP (5 – 7 days) or LOP (>7 days) by revisiting the patients on day 7.

Death was defined as pneumonia related if the pneumonia was designated as the underlying or immediate cause of death or was determined to have a major contributing role in the cause of death.

The underlying risk factors for these patients were noted and revisiting of patients were done regularly to know the outcome of the patients and their total duration of mechanical ventilation and their stay in ICU.

STATISTICAL ANALYSIS:

Excel and SPSS 12 were used for data analysis

CONFLICT OF INTEREST: none

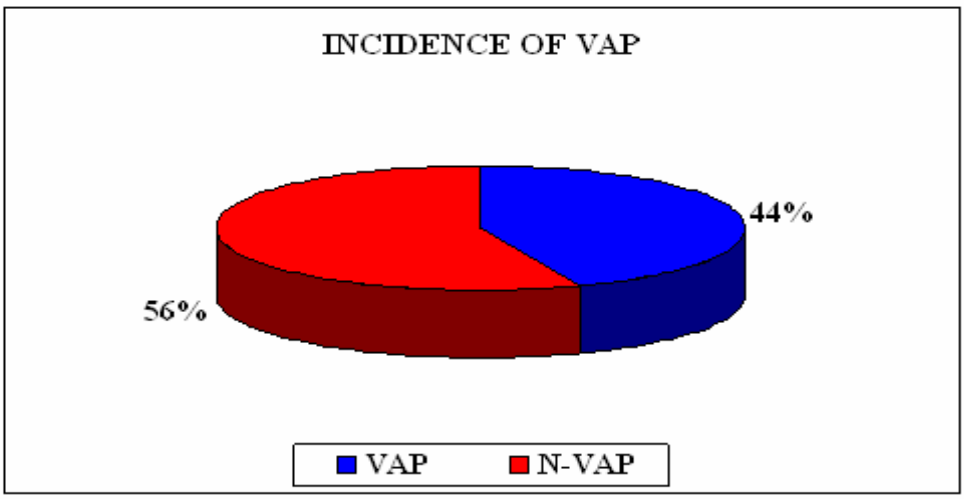
FINANCIAL SUPPORT : Nil

RESULTS AND OBSERVATIONS

TABLE 1

INCIDENCE OF VAP

	No. of patients	Percentage
VAP	22	44%
N-VAP	28	56%
Total	50	100%

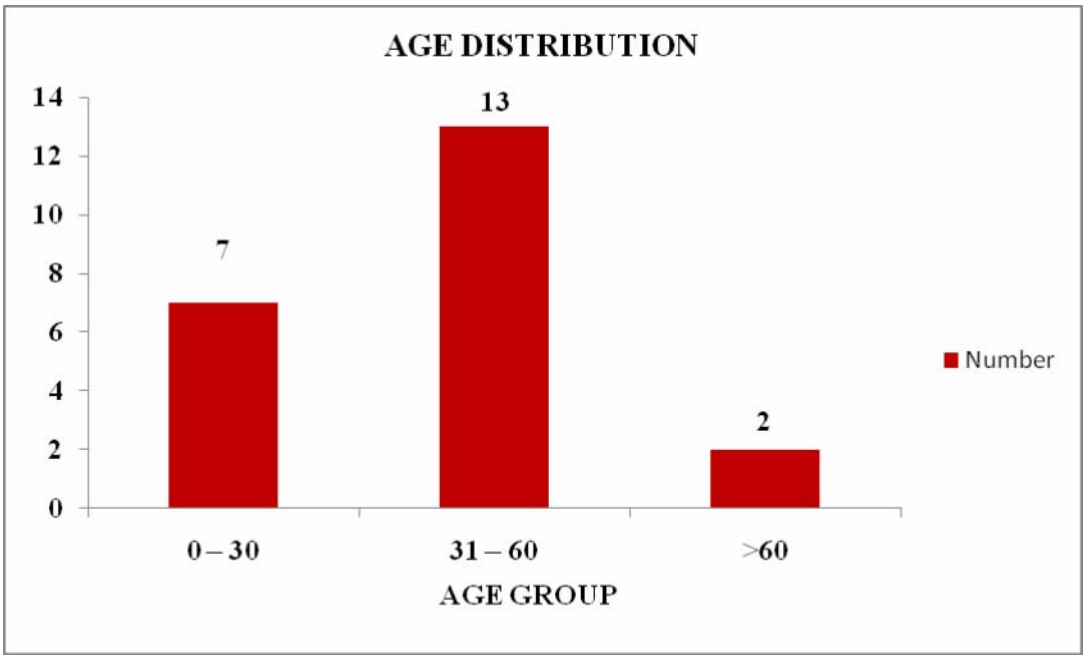


The incidence of VAP in our study is 44%

TABLE 2

AGE DISTRIBUTION OF CASES

S.No.	Age group	Number	Percentage
1.	0 – 30	7	31.81%
2.	31 – 60	13	59.09%
3.	>60	2	9.10%

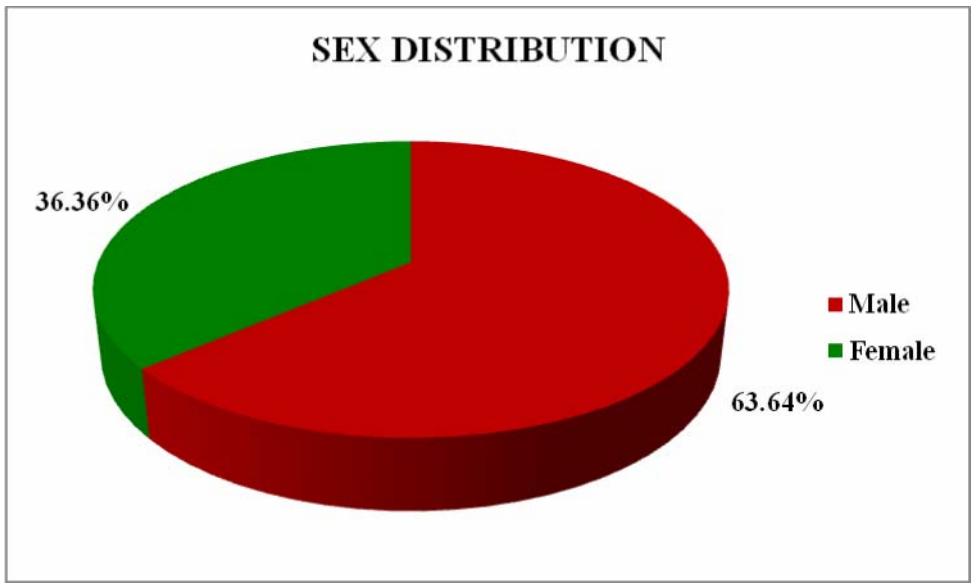


Majority of patients were in the group of 31 – 60 years. The number of people between 31 – 60 years accounts for 59%.

TABLE 3

SEX DISTRIBUTION

S.No.	Sex	Frequency	Percentage
1.	Male	14	63.64%
2.	Female	8	36.36%

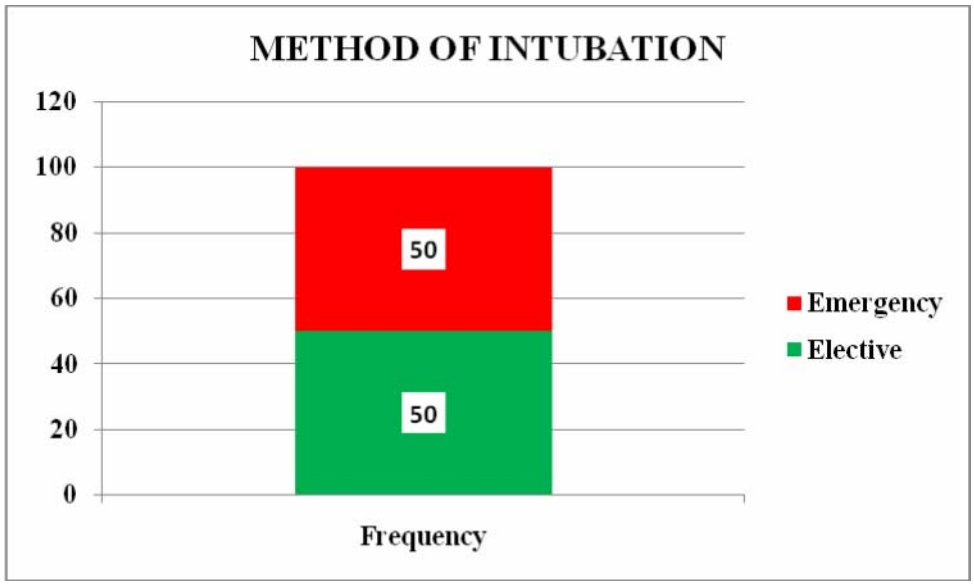


Incidence of VAP was more in male compared to females in our study. 14 out of 22 were males.

TABLE 4

METHOD OF INTUBATION

	Frequency	Percentage
Elective	**50**	**50%**
Emergency	**50**	**50%**

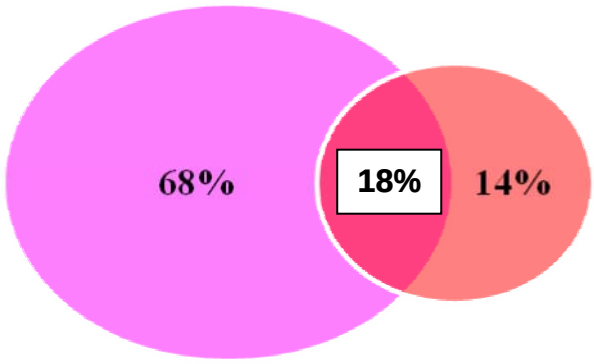


In our study 50% of patients underwent elective and 50% patients underwent emergency distribution.

TABLE 5

X-RAY FINDING IN THE CASES

S. No.	Lobar distribution	Frequency	Percentage
1.	Right side	15	68.18%
2.	Left side	3	13.63%
3.	Bilateral	4	18.18%

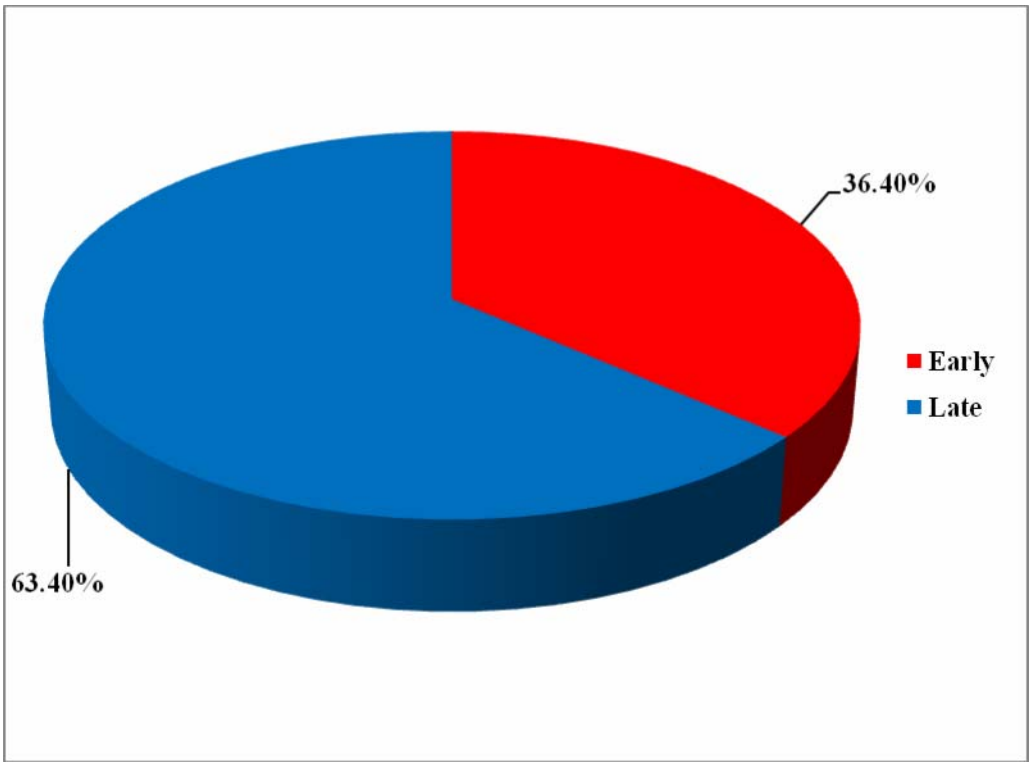


In majority of over cases, the CXR infiltrate was in the Right lung which comes around 68.2%.

TABLE 6

EARLY Vs LATE VAP

	Frequency	Percentage
Early	**8**	**36.4%**
Late	**14**	**63.4%**

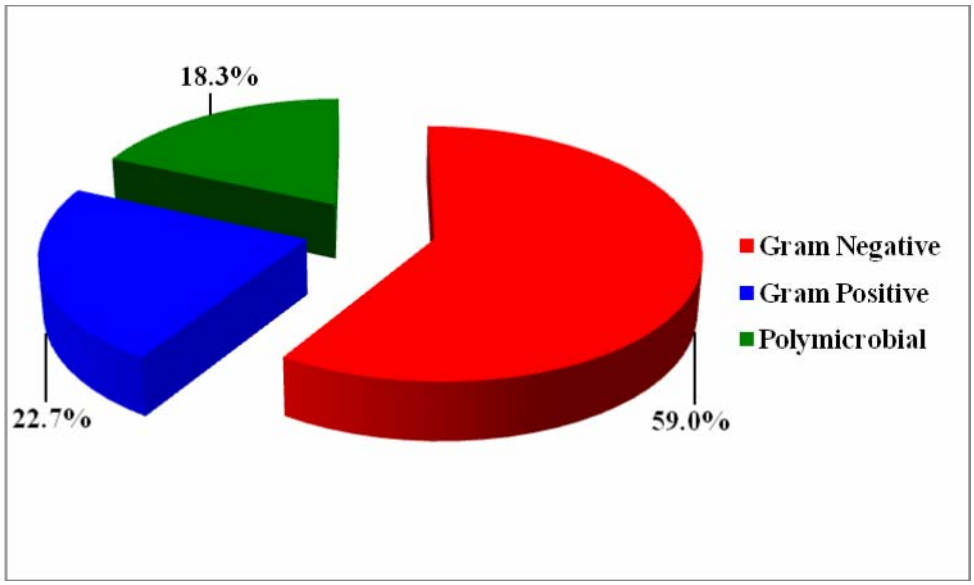


The percentage of EOP & LOP is 36.4% and 63.4% respectively.

TABLE 7

PROFILE OF ORGANISM

	Frequency	Percentage
Gram Negative	**13**	**59.0%**
Gram Positive	**5**	**22.7%**
Polymicrobial	**4**	**18.3%**

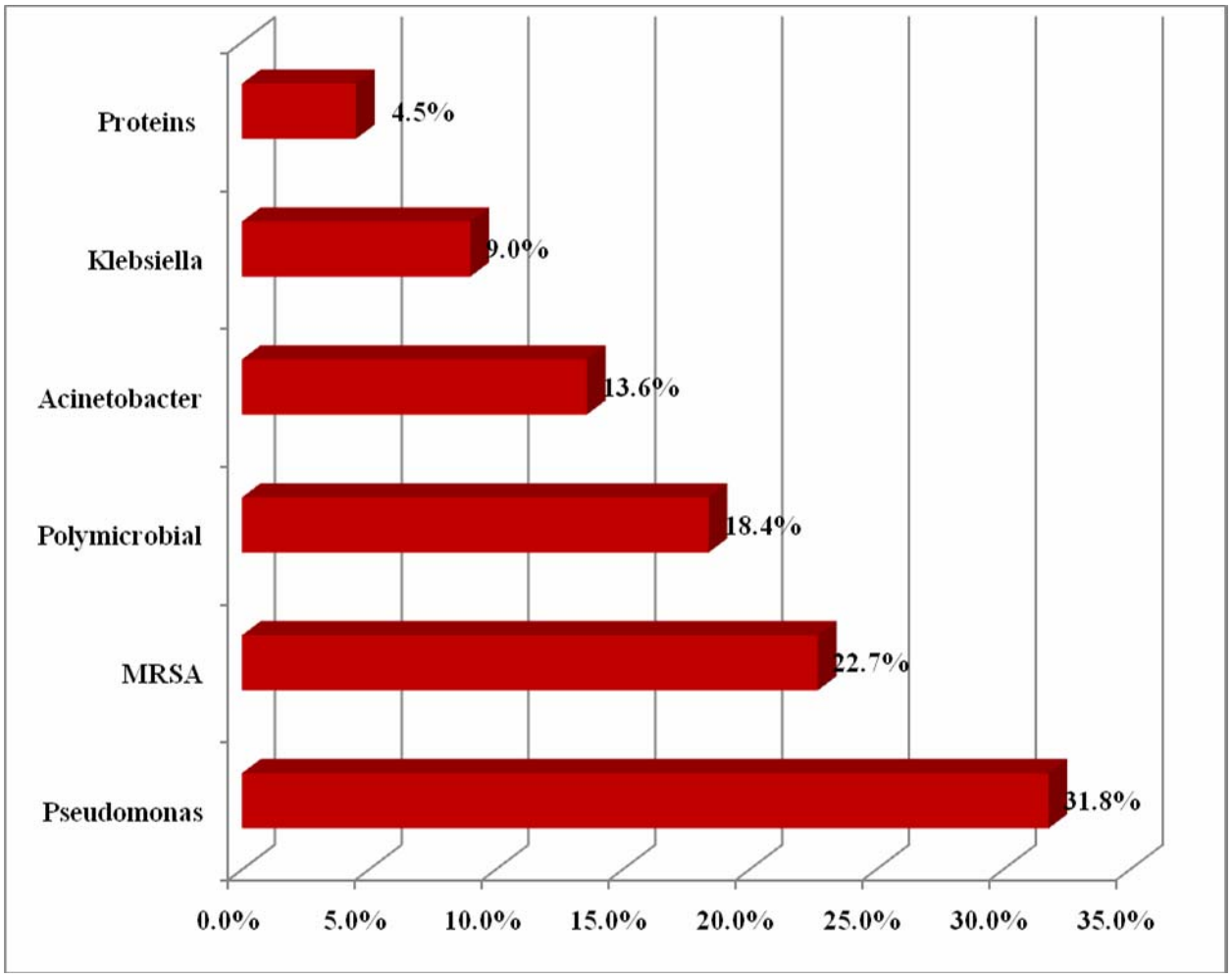


The percentage of gram negative organisms (59.9%), gram positive (22.7%) & polymicrobes (18.3%)

TABLE 8

AETIOLOGY

S. No.	Micro-organism	Frequency	Percentage
1.	Pseudomonas	7	31.8%
2.	MRSA	5	22.7%
3.	Polymicrobial	4	18.4%
4.	Acinetobacter	3	13.6%
5.	Klebsiella	2	9.0%
6.	Proteins	1	4.5%

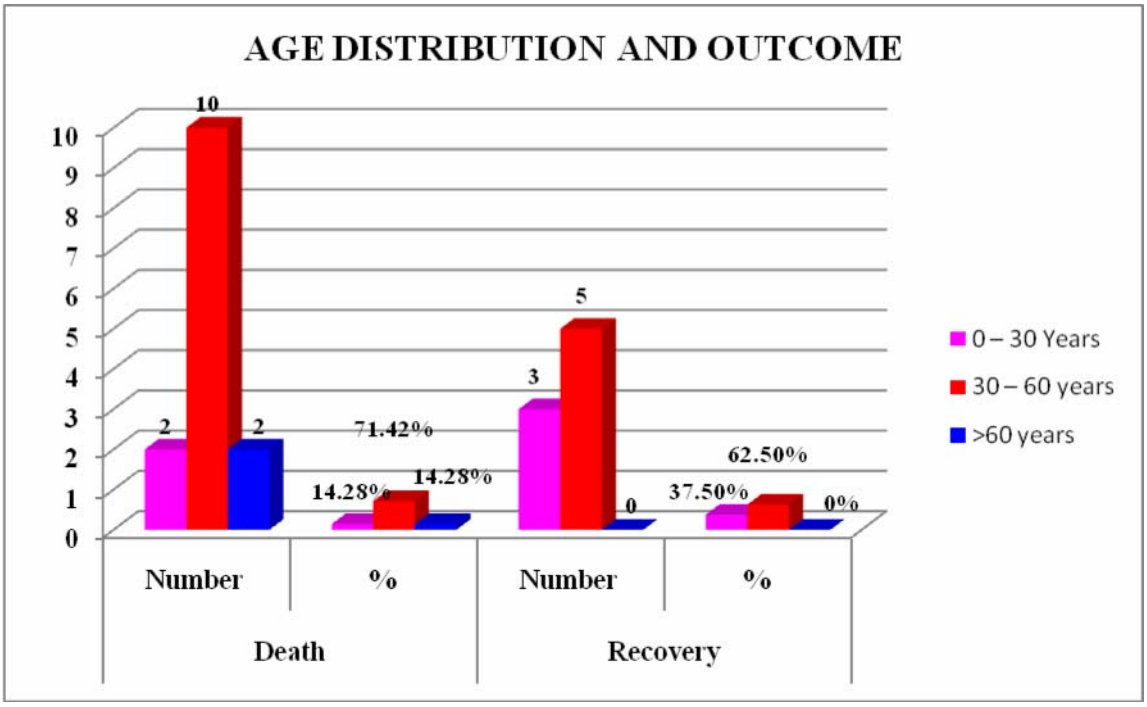


The organisms found in cultures in the descending frequency were pseudomonas, MRSA, Polymicrobial followed by acinetobacter.

TABLE 9

AGE DISTRIBUTION AND OUTCOME

Age	Death		Recovery	
	Number	%	Number	%
0 – 30 Years	2	14.28%	3	37.5%
30 – 60 years	10	71.42%	5	62.5%
>60 years	2	14.28%	0	0%

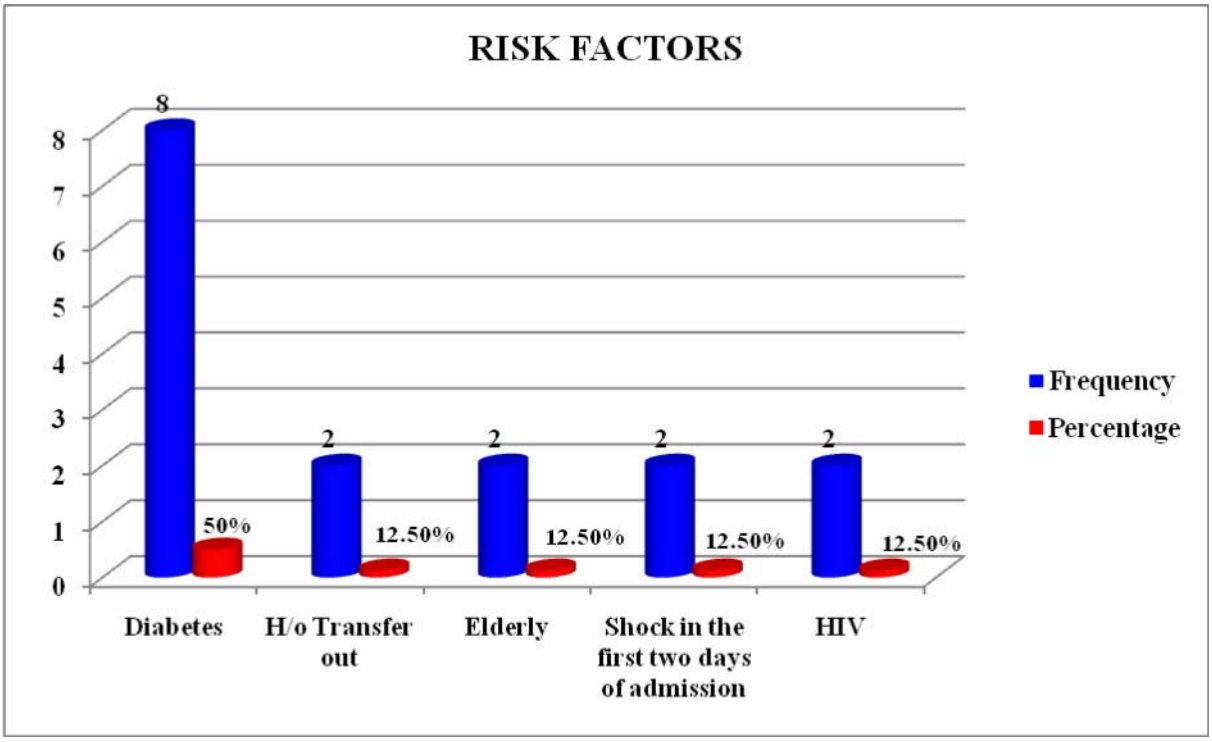


The mortality rate was high in patients of age group 30 – 60 years which accounts for 71.4% of total deaths.

TABLE 10

RISK FACTORS

S.No.	Risk Factor	Frequency	Percentage
1	Diabetes	8	50%
2	H/o Transfer out	2	12.5%
3	Elderly	2	12.5%
4	Shock in the first two days of admission	2	12.5%
5	HIV	2	12.5%

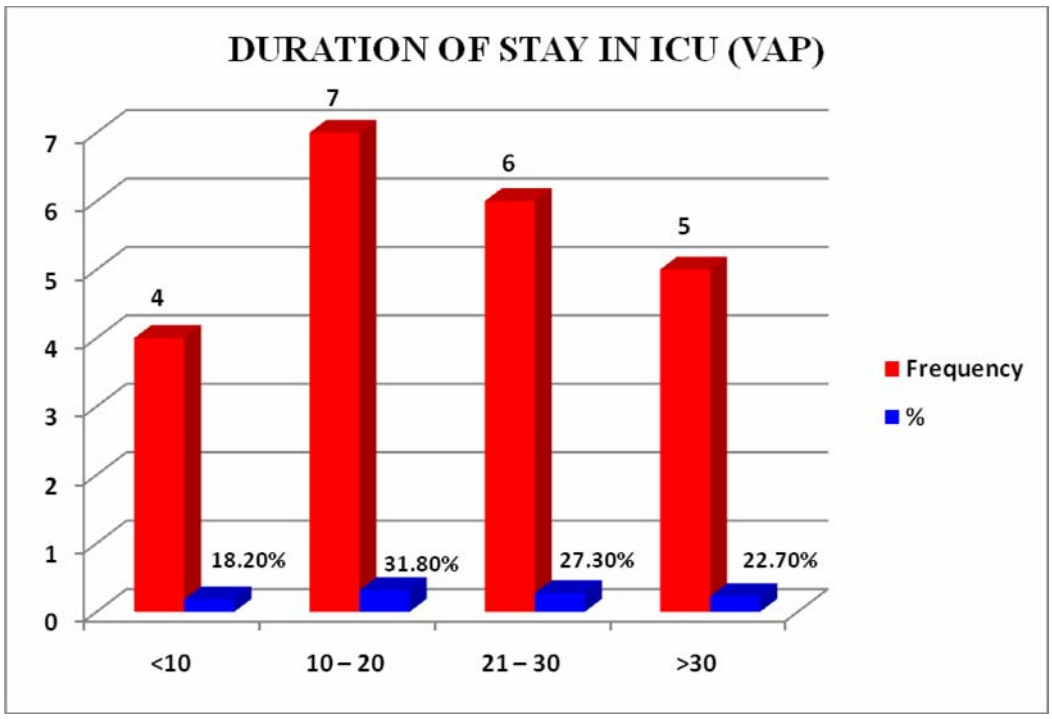


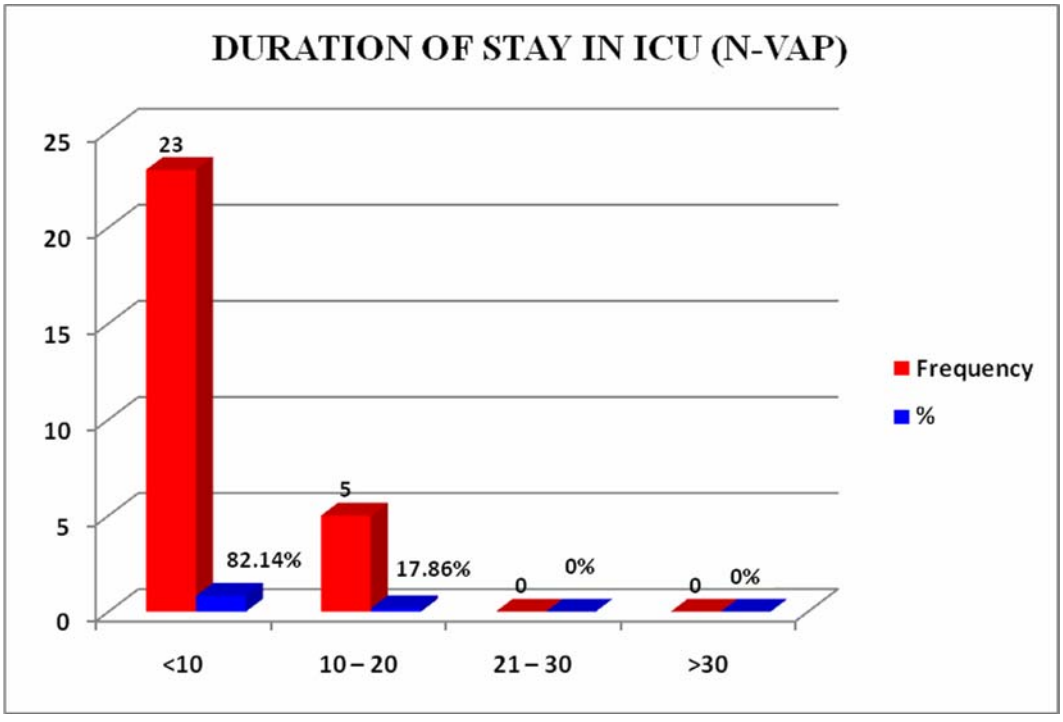
The major risk factor found in our study was Diabetes Mellitus.

TABLE 11

DURATION OF STAY IN ICU

S.No	VAP			N-VAP	
	Days	Frequency	%	Frequency	%
1	<10	4	18.2%	23	82.14%
2	10 – 20	7	31.8%	5	17.86%
3	21 – 30	6	27.3%	-	-
4	>30	5	22.7%	-	-





The mean duration of stay in the hospital who developed VAP was 10 – 20 days without VAP gp is < 10 days.

DISCUSSION

1. Incidence

Incidence of VAP in our govt.general hospital is 44% ,where as in united states VAP occurs in up to 25% of all people who require mechanical ventilation.

2. Age distribution

The percentage of patients with VAP in different age groups is as follows

<30years- 31.81%

31-60years- 59.99%

>60years-9.1%

The higher incidence in the age group (31-60) can be attributed to more number of patients getting admitted &undergoing ventilation in this age group.It may also be due to their associated co morbid conditions.

3. Sex distribution

In our govt.hospital two third of the cases were males (63.6%) remaining cases one third were (36.4%) females.

4. Method of intubation

There is equal incidence of VAP in both elective& emergency intubation.

5. Chest X-ray infiltrates

In our study 68.2%of patients had infiltrates in right lung.13.6%of patients in the left lung 18.2% bilaterally . The higher percentage of infiltrates in the right lung lower lobe is because of aspiration being the most common precipitating factor for VAP. Autopsy studies by Marquette, C. H., M. C. Copin, F. Wallet, R. Neviere, F. Saulnier, D. Mathieu, A. Durocher, P. Ramon, and A. B. Tonnel. 1995 have indicated that VAP frequently involves posterior right lower lobe.

6. Types of VAP

The percentage of patients with early onset VAP is 36%, late onset VAP is 63.4%.This is because probability of getting VAP increases with the duration of mechanical ventilation. Langer, Mosconi, Cigada, & Mandelli (1989) analyzed the relationship between artificial ventilatory support and pulmonary infection in 724 critically ill patients who had received prolonged (greater than 24 h) ventilatory assistance since admission to ICU. They found that the risk for VAP increased from 5% in patients receiving one day of respiratory assistance to 68.8% in patients receiving more than 30 days.

7. Profile of organism

The profile of organism in our study as follows gram negative 59%, gram positive 22%, polymicrobial 18.3%.

The organism cultured in our study in descending order were pseudomonas (31.8%) ,MRSA(22.7%), polymicrobials(18.4%), acinetobacter(13.6%), klebsiella(9%) proteus(4.5%)

reflecting the higher incidence of MDR organisms in patients with VAP, unlike in community acquired pneumonia where streptococcus pneumonia is common.

Study conducted by Faisal Wahid, Naveed Masood, Asadullah Jafri. Nosocomial pneumonia in mechanically ventilated patients Pak Armed Forces Med J Sep showed the following profile of organisms including Pseudomonas aeruginosa(26%), Staphylococcus aureus(20%), Acinetobacter spp.(9%), Proteus spp. (6%), Haemophilus spp. (6%), Escherichia coli (6%), Klebsiella spp. (3%), Streptococcus pneumoniae (3%), Corynebacteria spp. (3%), and Polymicrobial flora (9%).

8. Mortality

Mortality in our study according to the age distribution is as follows

<30 years-14.28%

31-60 years-71.42%

>60 years-14.28%

The greater mortality in the age group 31-60 years probably attributed to their associated co morbid conditions.

9. Risk factors

The risk factors for VAP found in our study were diabetes mellitus (50%),elderly age group, transferring out of ICU(for imaging & special tests),shock in the first 2 days of admission & immune compromised status(HIV).

10 Morbidity

Patients with VAP had prolonged stay in ICU(10-20 days)unlike in patients without VAP(<10 days). The study conducted by Boyce, J. M., G. Potter-Bynoe, L. Dziobek, and S. L. Solomon showed an increased ICU lengths of stays (LOS) from 4 to13 days. Bercault & Boulain, 2001; Rello et al., 2002. showed that the development of VAP increases the length on the mechanical ventilator by 4 days, critical care and hospital lengths of stay (LOS) by 4 and 9 days, respectively.

CONCLUSION

1. Method of intubation emergency or elective did not change the incidence of VAP.
2. The incidence of VAP increases with the duration of mechanical ventilation.
3. Aspiration is major precipitating factor for developing VAP.
4. High incidence of MDR organisms in patients with VAP unlike in community acquired pneumonia.
5. Diabetes is one of the major risk factor to develop VAP
6. Duration of stay in ICU patients with VAP very much pronged unlike in N- VAP .

PERFORMA

Name :

Age:

gender:

Complete diagnosis:

Duration of mechanical ventilation/ hospitalisation:

Indication for intubation:

Emergency/Elective:

Preventive measures undertaken:

Positioning	
Suctioning	
Oral care	
Antibiotics	

Diagnosis of VAP: EARLY / LATE

1	Chest X –ray	
2	Temp	
3	TLC	
4	TBA aspirate	

CBC	RFT	LFT	URINE
Hb	Sugar	TB	Albumin
TC	Urea	DB	Sugar
DC	Creatinine	SGOT	deposits
ESR	Na+	SGPT	Pus cells
platelets	K+	ALP	organisms
PCV	Blood culture	Total protein/albumin	Urine culture

Others:

ECG-

ABG-

CT Chest-

Treatment:

Outcome:

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INSTITUTIONAL ETHICAL COMMITTEE
MADRAS MEDICAL COLLEGE,CHENNAI-600 003.

Telephone : 25363970

Fax :044 – 253-5115
:044 25363970

L.Dis.No. 14597/ME5/EthicsDean/MMC/2009 Dated .09.2009

Title of the work : "Incidence and etiology of ventilator associated pneumonia in intensive care patients"

Principal Investigator : Dr. Rajalakshmi. M.D. Professor of Internal medicine madras medical college Ch-3

Department : Pharmacology seminar hall, madras medical college Ch-3.

The request for an approval from the Institutional Ethical Committee(IEC) was considered on the IEC meeting held on 23rd September 2009 at 2.00P.M. in Madras Medical College, Deans, Chamber, Chennai-3.

The members of the Committee, the Secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The principal investigator and their term are directed to adhere the guidelines given below:

1. You should get detailed informed consent from the patients/participants and maintain confidentiality.
2. You should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.
3. You should inform the IEC in case of any change of study procedure, site and investigation or guide.
4. You should not deviate form the area of the work for which I applied for ethical clearnance.
5. You should inform the IEC immediately, in case of any adverse events or serious adverse reactions.
6. You should abide to the rules and regulations of the institution(s).
7. You should complete the work within the specific period and if any extension of time is required, you should apply for permission again and do the work.
8. You should submit the summary of the work to the ethical committee on completion of the work.
9. You should not claim funds from the Institution while doing the work or on completion.
10. You should understand that the members of IEC have the right to monitor the work with prior intimation.

SECRETARY
IEC, MMC,CHENNAI

CHAIRMAN
IEC MMC CHENNAI

21/10/09

DEAN
MADRAS MEDICAL COLLEGE
CHENNAI

MASTER CHART

S.No	Name	Age	Sex	Diagnosis	Indication	Elective/ Emergency	Risk Factor	Duration Ventilator	Chest X-ray
1	Babu	54	M	OPC	R/P	EM	DM	8	R - LL Infiltrates
2	Vijayakumar	60	M	CVA(H)	Poor GCS	EL	DM/H/o Transfe	6	R - M/LL Infiltrates
3	Arun	28	M	Snake Bite (N)	R/P	EM	-	4	-
4	Charles	45	M	DCLD/HRS	Shock	EM	Shock	3	-
5	Divya	19	F	Puerperal Sepsis	Shock	EM	Shock	5	L - LL infiltrates
6	Kalyani	44	F	Oleander	Cardio Respiratory Arrest	EM	-	2	-
7	Kannan	68	M	CVA(H)	Poor GCS	EM	DM/Old Age	3	-
8	Raja	36	M	Seizure disorder	Status	EM	-	4	R - LL Infiltrates
9	Arulkumar	28	M	CKD/Pulmonary Edema	Pulmonary Edema	EM	-	5	R & L - LL infiltrates
10	Murugan	24	M	GBS	Respiratory paralysis	EL	-	30	L - LL infiltrates
11	Shankar	37	M	DM/DKA	Poor GCS	EL	DM	14	R - LL Infiltrates
12	Velu	30	M	Hupokalemic PP	Respiratory paralysis	EL	-	15	R - LL Infiltrates
13	Karthick	32	M	Snake Bite (N)	Respiratory paralysis	EM	-	13	L - LL infiltrates
14	Devaraj	40	M	Myasthenia Gravis	Myasthenic Crisis	EM	-	17	R - UZ infiltrates
15	Sadhasivam	20	M	OPC	R/P	EM	-	10	R - UZ infiltrates
16	Dhanalakshmi	61	F	Acute CVA, RHD/MS/MR AS (past CMC)	Poor GCS	EL	DM	11	R - LZ inflitrates
17	Pachiammal	50	F	ADD/ARF/Sepsis	Shock	EM	Shock	9	R - UL/MZ infiltrates
18	Latha	22	F	Super valmet Hemi	R/P	EM	-	65	R - UL infiltran
19	Gowri	19	F	Mental retardation, Seizure	Status	EL	-	8	L - UZ infiltran
20	Anuradha	16	F	GBS	Respiratory paralysis	EL	-	10	R - LL Infiltrates
21	Alavudeen	48	M	CAD/Active MI/Cardiogenic shock	Shock	EM	Shock	3	B/L LL Infiltrates
22	Sakthivel	56	M	Acute Hepatic Failure	Poor GCS	EM	-	4	-
23	Vignesh	26	M	GBS	Respiratory paralysis	EL	-	20	R ML/LL and L LL Infiltrate
24	Balamurali	38	M	Snake Bite (N)	Respiratory Failure	EM	-	3	-
25	Latha	34	F	Anticonvulsant Tablet	Poor GCS	EL	-	3	R ML

			overdosage						Infiltrate

S.No	Temp	TLC	Tracheal Aspirate	Gram Stain	Culture	Interpretation	Early/Late	Sugar/Urea Creatinine	ABG	Others	Duration in ICU	Outcome
1	+	16800	NP	N	Pseudomonai	1	E	168/46/1.1	Resp.ALK	-	20	R
2	+	8900	P	-	Polymicrobial	1	E	206/54/1.8	Resp.ALK	-	18	D
3	+	10000	NP	-	-	0	-	106/40/0.8	-	-	10	R
4	+	11800	NP	-	-	0	-	66/106/2.0	Met Acid	-	5	D
5	-	10800	NP	-	-	0	-	78/66/2.4	Met Acid	-	8	D
6	-	8000	NP	-	-	0	-	148/48/1.4	-	-	3	D
7	-	11800	NP	-	-	0	-	298/48/3.4	Met Acid	-	5	D
8	+	-	NP	-	-	0	-	102/36/0.6	Resp.ALK	-	8	R
9	+	9600	NP	-	-	0	-	356/94/3.6	Met Acid	-	6	D
10	+	13800	P	N	Pseudo	1	L	124/36/1.2	Resp.ALK	-	30	D
11	+	14240	P	P	MRSA	1	L	146/76/2.0	Met ALK	-	16	R
12	+	14100	NP	N	-	0	-	446/80/2.1	Resp.ALK	-	20	R
13	+	9200	P	N	Pseudo	1	L	68/26/0.9	Met Acid	-	15	R
14	+	12100	P	N	Klebsicella	1	L	206/19/0.9	-	BAL	23	R
15	+	16200	NP	N	Pseudo	1	L	124/36/1.1	Resp.ALK	-	25	D
16	+	10400	P	-	Polymicrobial	1	L	105/57/1.3	-	-	31	D
17	+	10740	P	N	Acinetobacter	1	E	139/45/1	-	-	9	D
18	+	10400	P	P	MRSA	1	L	123/18/0.6	-	-	70	R
19	+	11300	P	N	Pseudomonas	1	E	62/15/0.5	-	-	13	R
20	+	16080	P	N	Acinetobacter	1	L	98/40/1.2	Resp.ALK	-	56	R
21	-	12100	NP	-	-	0	-	168/48/1.5	Met Acid	-	3	D
22	-	8900	NP	-	-	0	-	86/68/1.4	Met Acid	-	5	D
23	+	10800	P	N	Klebsicella	1	L	106/46/1.2	Resp.ALK	-	40	R
24	-	6800	NP	-	-	0	-	104/32/0.8	-	-	7	R
25	-	11800	NP	-	-	0	-	124/34/0.8	Met Acid	-	5	R

26	Barathi	24	F	RHD/MS/MR/AF/PHT	Pulmonary Edema	EM	-	4	B/L Base Infiltrate
27	Ganesan	72	M	CVA(H)	Poor GCS	EM	DM/Old Age/ Transfer out	4	L - LL infiltrates
28	Sridhar	42	M	TBM/Hydrolephalus	Poor GCS	EL	HIV	5	B/L - LL Infiltrate
29	Ramesh	48	M	DCLD/Hepatic Encephalopathy	Poor GCS	EM	-	7	-
30	Selvaraj	62	M	Metabolic Encephalopathy	Respiratory arrest	EM	DM	4	-
31	Kumar	39	M	Hanging/HIE	Respiratory Failure	EM	-	10	L - UL Infiltrate
32	Anandhan	58	M	CAD/CCF/Shock/DM/CKD	Poor GCS	EM	shock/DM	8	R - ML Infiltrate
33	Shankar	32	M	GBS	Respiratory Weakness	EL	-	18	B/L - LL Infiltrate
34	Ravi	18	M	Anticonvulsant Tablet overdosage	Poor GCS	EM	-	4	-
35	Palani	52	M	Glioma R Frontal Lobe	Status epilepticus	EM	-	6	-
36	Rajan	48	M	Seizure disorder	Status	EM	-	3	-
37	Latha	32	F	SLE/Lupus Nephritis	Poor GCS	EM	-	4	-
38	David	72	M	CVA(I)	Poor GCS	EM	-	3	-
39	Madhu	52	M	ARF/Leptospirosis	Shock	EM	Shock	4	L - LL infiltrate
40	Mary	48	F	Viral Encephalitis	Status	EM	-	12	R - LL Infiltrate
41	Vishnulingam	58	M	GBS/DM	Respiratory paralysis	EL	DM	28	R - LL Infiltrate
42	Kalaiselvi	42	F	Hypothyrodism/DCM	Coma	EM	-	6	-
43	Patchiammal	58	F	DM/SHT/Metabolic Encephalopathy	Poor GCS	EM	DM	8	R - LL Infiltrates
44	Rajaram	14	M	Scorpion sting	Shock/Pulmonary Edema	EM	-	3	-
45	Pitchai	42	M	HBS AG +ve/Postnecrotic cirrhosis/HE	Poor GCS	EM	-	8	R - ML/LL Infiltrate
46	Karunakaran	30	M	GBS	Respiratory paralysis	EL	-	16	R - LL/L - LL Infiltrate
47	Muthukumar	46	M	DCLD/SBP	Shock	EM	Shock	4	-
48	Ilayaraja	52	M	DM/L Pyelonephritis	shock	EM	Shock	8	-
49	Stella	66	F	CVA (H) / DM	Poor GCS	EM	DM	5	R - ML/LL Infiltrate
50	Saravanan	38	M	Snake Bite (N)	Respiratory paralysis	EL	-	3	-

26	-	10800	NP	-	-	0	-	96/28/0.6	Met Acid	-	4	D

27	-	9200	P	-	-	0	-	196/56/1.6	-	-	4	D
28	+	6800	P	N	Acinetobacter	1	E	86/32/1.0	Resp.ALK	-	5	D
29	-	11800	NP	-	-	0	-	136/48/1.2	-	-	7	D
30	-	12600	NP	-	-	0	-	192/56/2.4	-	-	5	D
31	+	10800	P	-	Polymicrobial	1	L	118/32/0.8	-	-	25	R
32	-	9600	NP	-	-	0	-	116/56/3.2	-	-	8	D
33	+	14600	P	N	Proteus	1	L	108/42/1.2	Resp.ALK	-	30	R
34	+	11400	NP	-	-	0	-	124/36/0.6	Met Acidosis	-	7	R
35	-	7200	NP	-	-	0	-	108/42/1.2	-	-	6	D
36	+	10800	NP	-	-	0	-	158/32/1.0	Resp.ALK	-	7	R
37	+	9600	NP	-	-	0	-	168/68/5.6	-	-	6	D
38	-	10800	NP	-	-	0	-	108/42/1.2	-	-	4	D
39	-	18600	NP	-	-	0	-	96/48/3.2	Metabolic Alkalaosis	-	4	D
40	+	20400	P	N	Pseudomonas	1	L	112/32/1.2	-	LP Lymphocytosis	18	R
41	+	16200	P	P	MRSA	1	L	302/48/1.8	-	-	42	R
42	-	9600	NP	-	-	0	-	102/44/0.6	Metabolic Alkalaosis	T3 ↓ T4 ↓	10	D
43	+	12600	P	P	MRSA	1	E	102/32/1.8	-	-	10	D
44	-	10200	NP	-	-	0	-	142/32/1.0	-	-	6	R
45	+	10800	P	N	Pseudomonas	1	E	86/52/1.8	Metabolic Alkalaosis	-	9	D
46	+	12800	P	-	Polymicrobial	1	L	136/42/0.8	-	-	28	D
47	+	12200	NP	-	-	0	-	108/56/0.8	Metabolic Alkalaosis	-	4	D
48	+	14600	NP	-	-	0	-	288/72/2.8	Metabolic Alkalaosis	-	9	D
49	+	13800	P	P	MRSA	1	E	156/48/1.8	-	-	5	D
50	-	9600	NP	-	-	0	-	124/40/0.8	-	-	6	D